

CLAIMS

What is claimed is:

- 1 1. A method for creating a magnetic head, comprising:
2 adding leads to a wafer stack having a free layer, a bias layer, and a spacer layer
3 between the free layer and bias layer, wherein a gap is formed between the
4 leads;
5 adding a protective layer to the wafer stack such that the gap is covered, the
6 protective layer also covering facing ends of the leads;
7 removing material from at least one side area of the wafer stack using the
8 protective layer as a mask;
9 removing the protective layer; and
10 processing a portion of the bias layer below the gap for reducing a magnetic
11 moment of the bias layer in the portion of the bias layer below the gap for
12 forming a sensor in which magnetic moments of end portions of the free
13 layer are pinned by magnetic moments of end portions of the bias layer.

- 1 2. The method as recited in claim 1, wherein the magnetic moments of the end
2 portions of the free layer are pinned antiparallel to the magnetic moments of the
3 end portions of the bias layer.

- 1 3. The method as recited in claim 1, wherein the leads are added to the wafer stack
2 by an additive process.
- 1 4. The method as recited in claim 1, wherein the gap is formed between the leads by
2 reactive ion etching.
- 1 5. The method as recited in claim 1, wherein the protective layer includes a resist
2 undercoat and a second layer of resist above the resist undercoat.
- 1 6. The method as recited in claim 5, further comprising applying a developer to the
2 resist undercoat for removing a portion of the resist undercoat such that opposite
3 ends of the resist undercoat along a plane parallel to an upper surface of the wafer
4 stack are closer together than opposite ends of the second layer of resist.
- 1 7. The method as recited in claim 1, wherein the material in the at least one side area
2 of the wafer stack is removed by at least one of ion milling and sputter etching.
- 1 8. The method as recited in claim 1, wherein an edge of the at least one side area of
2 the wafer stack after removing the material is oriented at an acute angle relative to
3 a line perpendicular to a plane parallel to an upper surface of the wafer stack.
- 1 9. The method as recited in claim 1, wherein material is removed from both side
2 areas of the wafer stack, wherein edges of the side areas of the wafer stack after

3 removing the material taper towards each other in a direction away from the wafer
4 stack.

1 10. The method as recited in claim 1, wherein the protective layer is removed by a lift
2 off process.

1 11. The method as recited in claim 1, further comprising adding lead material to the at
2 least one side area of the wafer stack.

1 12. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by oxidation.

1 13. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by ion implantation.

1 14. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by milling.

1 15. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by at least one of self-aligned oxidation, self-aligned ion implantation
3 and self-aligned milling.

1 16. A magnetic head formed by the process of claim 1.

1 17. The magnetic head as recited in claim 16, wherein end regions of the leads taper
2 towards facing ends thereof.

1 18. The magnetic head as recited in claim 16, wherein the magnetic head has no hard
2 bias elements.

1 19. The method as recited in claim 16, wherein a thickness of the bias layer in a
2 direction perpendicular to a plane parallel to an upper surface of the wafer stack is
3 less than a thickness of the free layer in the same direction.

1 20. The method as recited in claim 18, wherein the thickness of the bias layer is less
2 than about 75% of the thickness of the free layer.

1 21. A method for creating a magnetic head, comprising:
2 adding leads to a wafer stack having a free layer, a bias layer, and a spacer layer
3 between the free layer and bias layer, wherein a gap is formed between the
4 leads;
5 adding a protective layer to the wafer stack such that the gap is covered, the
6 protective layer also covering facing end regions of the leads;
7 removing material from at least one side area of the wafer stack using the
8 protective layer as a mask, wherein the protective layer includes a resist
9 undercoat and a second layer of resist above the resist undercoat;

10 applying a developer to the resist undercoat for removing a portion of the resist
11 undercoat such that opposite ends of the resist undercoat along a plane
12 parallel to an upper surface of the wafer stack are closer together than
13 opposite ends of the second layer of resist;
14 removing the protective layer; and
15 processing a portion of the bias layer below the gap for reducing a magnetic
16 moment of the bias layer in the portion of the bias layer below the gap for
17 forming a sensor in which magnetic moments of end portions of the free
18 layer are pinned antiparallel to magnetic moments of end portions of the
19 bias layer.

1 22. The method as recited in claim 21, wherein the magnetic moments of the end
2 portions of the free layer are pinned antiparallel to the magnetic moments of the
3 end portions of the bias layer.

1 23. The method as recited in claim 21, wherein the leads are added to the wafer stack
2 by an additive process.

1 24. The method as recited in claim 21, wherein the gap is formed between the leads
2 by reactive ion etching.

- 1 25. The method as recited in claim 21, wherein the material in the at least one side
2 area of the wafer stack is removed by at least one of ion milling and sputter
3 etching.
- 1 26. The method as recited in claim 21, wherein an edge of the at least one side area of
2 the wafer stack after removing the material is oriented at an acute angle relative to
3 a line perpendicular to a plane parallel to an upper surface of the wafer stack.
- 1 27. The method as recited in claim 21, wherein material is removed from both side
2 areas of the wafer stack, wherein edges of the side areas of the wafer stack after
3 removing the material taper towards each other in a direction away from the wafer
4 stack.
- 1 28. The method as recited in claim 21, wherein the protective layer is removed by a
2 lift off process.
- 1 29. The method as recited in claim 21, further comprising adding lead material to the
2 at least one side area of the wafer stack.
- 1 30. The method as recited in claim 21, wherein the magnetic moment of the bias layer
2 is reduced by oxidation.

1 31. The method as recited in claim 21, wherein the magnetic moment of the bias layer
2 is reduced by ion implantation.

1 32. The method as recited in claim 21, wherein the magnetic moment of the bias layer
2 is reduced by milling.

1 33. A magnetic head formed by the process of claim 21.

1 34. The magnetic head as recited in claim 33, wherein end regions of the leads taper
2 towards facing ends thereof.

1 35. The magnetic head as recited in claim 33, wherein the magnetic head has no hard
2 bias elements.

1 36. The magnetic head as recited in claim 33, wherein a thickness of the bias layer in
2 a direction perpendicular to a plane parallel to an upper surface of the wafer stack
3 is less than a thickness of the free layer in the same direction.

1 37. The magnetic head as recited in claim 36, wherein the thickness of the bias layer
2 is less than about 75% of the thickness of the free layer.

1 38. A magnetic storage system, comprising:
2 magnetic media;

- 3 at least one head for reading from and writing to the magnetic media, each head
- 4 having a sensor formed according to the method recited in claim 1;
- 5 a write element coupled to the sensor;
- 6 a slider for supporting the head; and
- 7 a control unit coupled to the head for controlling operation of the head.